

## Organic Catalysis: A Broadly Useful Strategy for Living Polymerization

J. Hedrick and R. Waymouth, IBM and Stanford University,

*Hedrick* (IBM) and *Waymouth* (Stanford) have developed a new organic catalyst platform based on N-heterocyclic carbenes (NHC) (a form of carbon which has six instead of the usual eight electrons) leading to a versatile type of chemistry. The widespread use of NHCs is complicated due to their extreme air and moisture sensitivity, necessitating glove box preparations. A simple one-step approach to "protected" NHCs allows us to "think outside the box" (i.e., the glove box), moving this class of elusive compounds from transient chemical curiosities to routine bench chemistry. Importantly, *Hedrick* and *Waymouth*, in association with *Gast*, have also discovered that ionic liquids, an environmentally preferable solvent alternative, are both solvents and precatalyst reservoirs for NHCs, providing a reaction/recycle protocol using commercial materials. The ramifications of this green, environmentally friendly means of depolymerizing (recycling) polyethylene terephthalate (PET) are enormous as these materials will contribute more than 1 billion pounds of waste to land-fills this year alone!

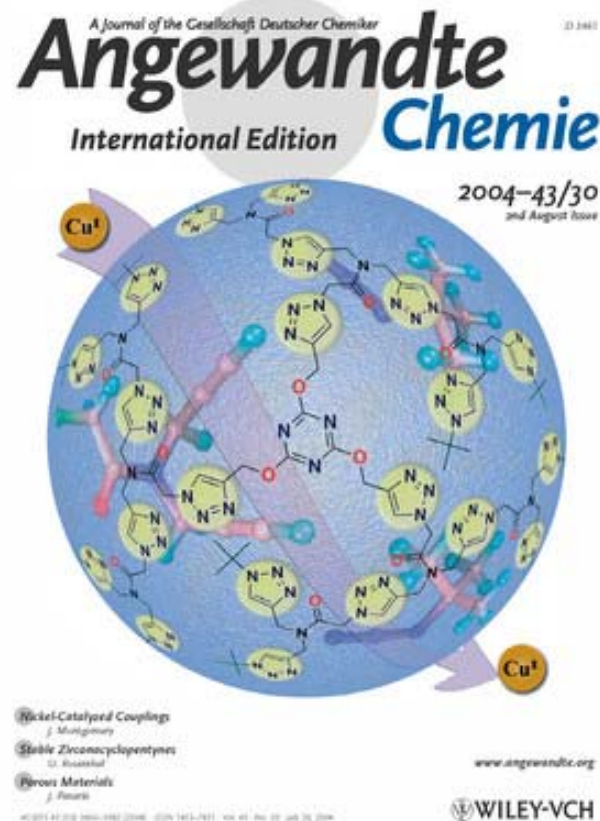


# Efficiency and Fidelity in Dendrimer Synthesis

Craig J. Hawker, IBM Almaden, DMR-0210247 and INT-0129303

A highly efficient route to triazole linked dendrimers is now available thanks to the unprecedented reliability of the Cu(I)-catalyzed ligation of terminal acetylenes and azides. This “Click Chemistry” is highly regioselective, resulting in 1,4-disubstituted triazoles. A wide variety of functional groups are compatible with the process and the only major byproduct formed in the reaction is NaCl. This greatly facilitates purification and all second generation and some third generation dendrons were directly isolated as pure solids (i.e. no chromatographic separations), meeting the requirements for large scale applications.

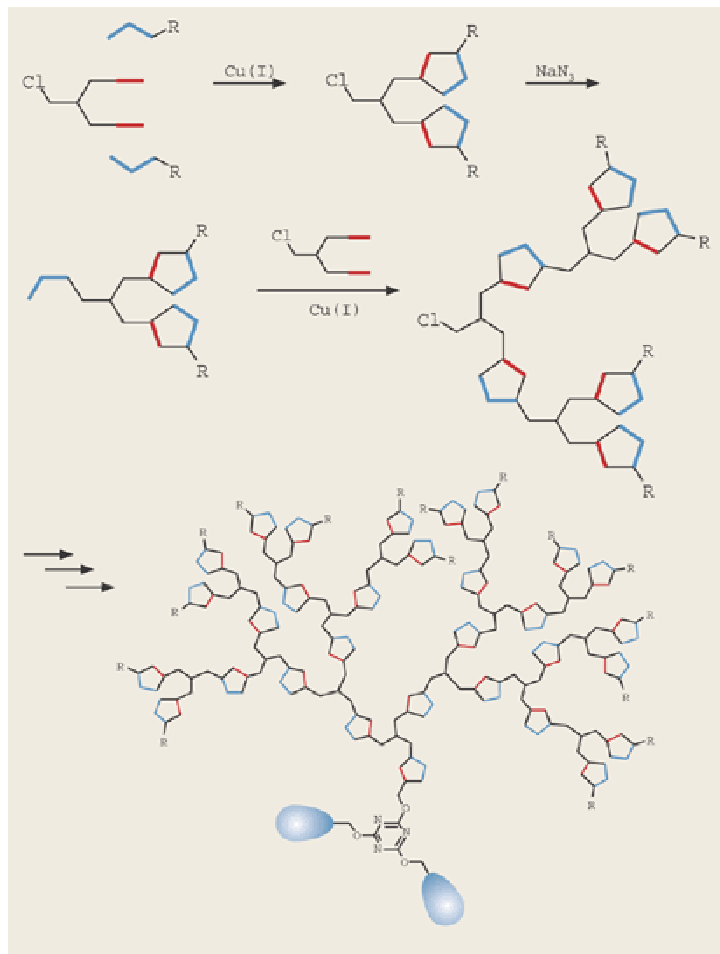
*Angew. Chem. Int. Ed.* **2004**, 43, 3928-3932



Journal cover showing structural diversity possible in dendrimer syntheses based on the highly efficient construction of triazoles from functionalized azides and alkynes

# Efficiency and Fidelity in Dendrimer Synthesis

Craig J. Hawker, IBM Almaden, DMR-0210247 and INT-0129303



General synthetic strategy for the construction of dendrimers using *Click Chemistry* showing the versatility in repeat unit and chain end selection

## Education and Outreach:

Under these grants, a very diverse and highly interactive group of international researchers have come together to collaborate and tackle a major challenge – a viable and economical method for the construction of dendrimers. Students from a classical organic synthesis group (Sharpless) and polymeric materials groups (Hawker, Fréchet and Voit) have worked together and benefited from the cross-disciplinary training and exposure to new areas. Arnulf Scheel, a Ph.D. student from Brigitte Voit's group in Dresden performed many of the initial studies and spent 3 months at IBM. An undergraduate student, Anne Nugent from Washington University, performed a 3 months summer internship at IBM and Berkeley working on the program before returning to Karen Wooley's group at WU, where the work continues. Dr. Jeffrey Pyun was a post-doctoral worker from Jean Fréchet's group at UC Berkeley who spent 6 months at IBM conducting research into *Click Chemistry* and its application to dendrimers and other polymers. Jeff has recently left to become an Assistant Professor at the University of Arizona

## **EDUCATION NUGGET: 2003 EASTSIDE SCIENCE FAIR**

CPIMA worked with Eastside College Preparatory School to put together their first school science fair on May 1, 2003. Eastside, in East Palo Alto, CA, is an independent, nonprofit high school offering a community-based alternative to academically motivated high school students from the low income, minority communities of East Palo Alto and eastern Menlo Park, California.

CPIMA worked coordinating with the 6th grade teacher, middle school (7th and 8th grades) science teacher and high school chemistry/biology teacher at Eastside to integrate science fair projects into their curricula for all 6th, 7th, 8th and 10th grade students. The students were divided into groups of two to four, and each group was paired with a Stanford graduate student as their mentor. In total, 81 students participated in 33 groups with 35 mentors. Projects ranged from comparing soil qualities of East Palo Alto and Palo Alto to the physics of model airplane flying to which wavelength of light will best power a solar car.

Over 150 people attended the Fair including the students, mentors, teachers and administrators from the school, parents, siblings and other school volunteers. A panel of CPIMA judges visited the projects and talked to the students about their work. All students were later given awards at a school assembly.

